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GUIDED ROCKETS AND MISSILES, CLASS AIR-TO-AIR

- POLAND -

by T. Burakowski and A. Sala

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GUIDED ROCKETS AND MISSILES, CLASS AIR-TO-AIR

- POLAND -

/Following is a translation of a portion of an article by T. Burakowski and A. Sala in the Polish-language periodical Wojskowy Przeglad Lotniczy (Military Air Review), Warsaw, Vol. XIII, No 4., April 1960, pages 58-63./

The efficiency of the fire of fighter planes equipped with guided rockets and missiles of the air-to-air class mainly depends on their arrival in the attack area and on the probability of a missile fired from the fighter plane to reach the target.

We shall briefly consider the problem of the correct use of guided rockets and missiles of the air-to-air class by fighter planes, which specialize in this type of armament.

Fighter planes serve mainly to destroy bombers. However, it is possible to have fighters attacking other fighters. This especially takes place when intercepting fighters fight fighters which accompany bombers. The modern air fight is marked by the tremendous speed with which situations change. The area of future air fights will cover several dozen and even a few hundred kilometers, in both directions, from low altitudes to the stratosphere included. In view of the very great speed of this fight, if the first attack does not succeed, it will be often impossible to repeat it because the adversaries will lose contact.

The probability of bringing the fighter into an area from which he can fire at the target depends on the efficiency of the system directing the fighter from the ground, the reliability of navigational equipment on the plane, the size of the area of attack and permissible distortion in aiming. The area of attack and the permissible distortion of aiming are much larger for guided air rockets than for guns and missiles.

The probability of reaching the target depends on the quality of armament, dimensions of the war-head of the rocket, dimensions and flight parameters of the attacked plane and, insofar as guided rockets are concerned, the precision of the self-aiming system and the efficacity of action of the approach triggering device.

Knowing the factors on which depend these two probabilities and the influence of these factors on the importance of the probability, it is possible to evaluate statistically the probability q for bringing the fighter to the area of attack, and the probability p for reaching the target. Hence it is easy to compute what number of fighter planes is necessary to execute a certain task in the field of Air Defense.

The diagram in Figure 2 shows the dependence of the number of fighters armed with guns and machine guns, or missiles, and necessary to destroy 45 out of a total of 50 attacking bombers, on the probabilities p and q. If the probability q for bringing the fighter to the attack area from which he can fire efficiently is 0.50. and the probability p for destroying the target is 0.30, it will be necessary to use 710 fighter planes to execute the mission.

The situation is much more favorable when the fighter plane is equipped with guided rockets. The number of fighters necessary is much smaller. This case is represented in Figure 3. Just as in Figure 2, it shows the number of fighter planes necessary to destroy 45 out of a total of 50 attacking bombers in terms of the probabilities p and q. The diagram is based on the assumption that each fighter plane is equipped with two guided missiles. If the values of probabilities are the same as before ($q = 0.50$, $p = 0.30$), only 400 fighter planes will be necessary. However, statistics show that in this case the probability of bringing the fighter to the attack area is much higher and amounts to $q = 0.80$, as the result of the very large attack area and higher admissible aiming distortions. The probability of reaching the target also increases considerably, up to $p = 0.80$, in view of the greater weight of the war-head of guided rockets, the use of self-aiming system and the approach triggering device. Under those conditions, the execution of the mission requires only 79 fighter planes, i.e., about 1/10 of the number required in the case of a defense based on fighter planes aimed only with missiles or with guns and machine guns.

One ought also to mention that the increase in the number of fighters participating in the attack on bombers complicates the task of ground forces which are to direct the fighters, and decreases the probability of easily bringing the fighters to the attack area. When bombers are attacked by a considerable number of fighter planes armed with guided rockets, there occurs also a decrease in the probability for reaching the target, mainly as the result of the possibility of interference in the self-aiming rocket equipment.

A fighter plane equipped with guns or missiles and guided rockets of the air-to-air class may attack the bombers from the back curve or from the front curve, using barrage fire (Figure 4).

The first method of attack (Figure 4a), using automatic sights, has the advantage of permitting the fighter to repeat the attack. Obviously this method can only be used when the fighter plane has a higher speed than the bomber. The shortcoming of this method consists in the fact that the fighter remains for a rather long time in the fire area of the tail armament of the bomber. In addition, as the speed of both bombers and fighter planes is increasing, this manoeuver is also unprofitable, because it entails the waste of time during which the target, i.e., the attacked bomber, will have the opportunity of approaching the object defended by the fighter.

These defects may be avoided through the use of the second method of attack (Figure 4b). This method has already been applied, especially when the fighter plane did not have a higher speed than the bomber. Now this method is used because it permits the use of barrage fire. Such fire is mainly achieved with missiles. In the case of guns, this fire would have a weak intensity and could be used only if the rapidity of fire were sufficiently increased so that the number of effective shells in a series would be large enough to destroy the target. Even if we admit that one shell is enough to destroy the target, the fact that the bomber has a speed of about 300 m/sec, and that its vulnerable section is 10 m long, requires a rapidity of fire of 1800 shots/min. The simplest method consists therefore in firing a round of shots at the anticipated position, in order to "cover"target. Missiles are best suited for that purpose. They permit barrage fire even with the angles of approach nearing 90°. Of course, special sights, determing automatically the anticipated position, are used in such cases.

Another advantage of the front curve attack consists in the fact that the fighter remains very briefly in the fire area of the tail armament of the bomber. The fact that the attack can not be repeated is one of the weaknesses of this method.

Modern fighter planes are equipped both with missiles and with guided rockets.

The armament of a fighter with missiles demands that the plane carries computers necessary for the determination of the correct direction of its flight. Missiles ought to be used in fights at short distance where the target does not have the time to undertake an evading action.

Guided rockets are used for firing at long distance at the attacked bomber, and considerable distortions of aiming are acceptable. An important advantage of this type of armament his in the possibility of attacking the target at altitudes higher than the actual ceiling of the fighter plane.

Figure 5 shows the diagram of an attack both from front and back curve by fighters equipped with missiles and guided rockets. One notices that the angle of attack of fighters equipped with guided rockets is smaller than that of fighters equipped with missiles. This fact is particularly important in the case of a front curve attack, when the time for correcting the direction of attack is limited. For instance, if a fighter armed with missiles attacks at a speed of 300 m/sec a target flying at the same speed, the pilot has 1.5 seconds to avoid collision with the target. The use of guided rockets increases the safety of the attacking fighter since they can be fired from much greater distance.

A comparative analysis of guided rockets and missiles would be incomplete without the consideration of missiles equipped with an atomic warhead. In this case, the fact of missing as the result of errors in aiming, distribution of missiles and action of the target is compensated by the tremendous power of the payload. On the other

hand, the large dimensions of such missiles considerably effect the flight and tactical characteristics of the intercepting plane. In addition, the use of atomic warhead missiles in fighting bombers over one's own territory constitutes a considerable danger for one's own country. This armament may only be used over large desert areas or over the sea.

In summary, it may be stated that the further development of the air-to-air class rockets will go in the following directions:

- increase of the areas from which the fighter plane can fire effectively;
- increase of the acceptable distortions in the direction of firing of the missile, and thus a maximum reduction of the action of the fighter plane;
- increase of the probability of destroying the target by the rocket or the missile.

FIGURE APPENDIX

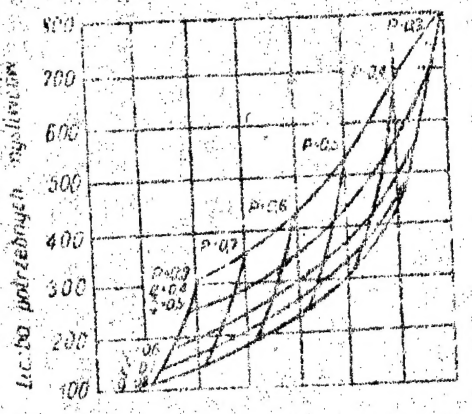

Figure 2. Dependency of the number of intercepting fighters (armed with machine guns, guns or missiles) necessary to destroy 45 bombers (out of the total number of 50 raiders) on the probability q (probability of bringing the fighters to the area of attack) and p (probability of reaching the target).

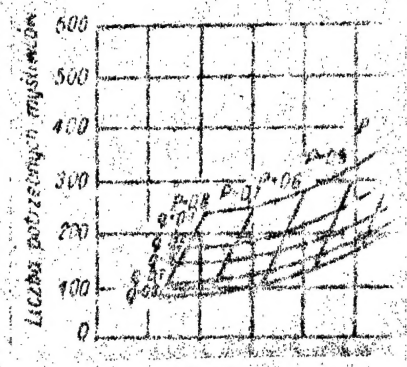

Figure 3. Dependency of the number of intercepting fighters, armed with guided rockets necessary to destroy bers out of a total of 50 raiders, for babilities p and

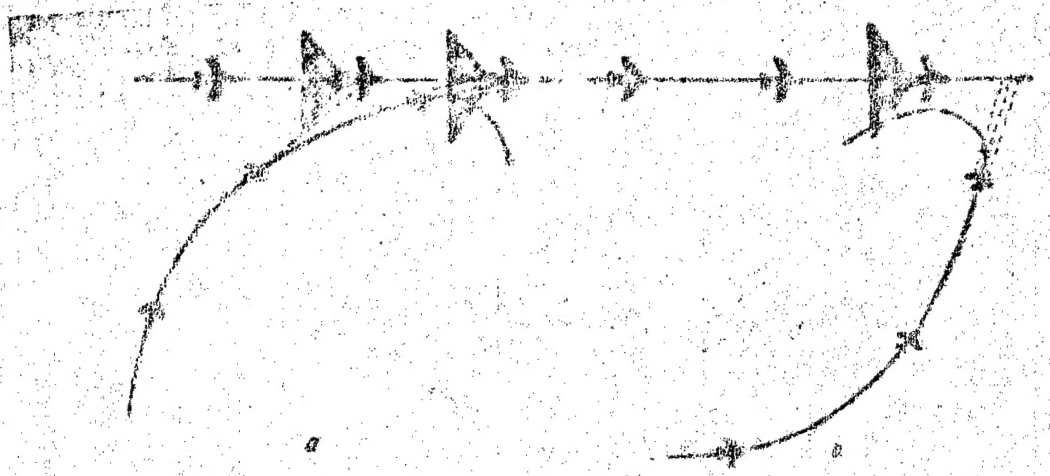

Figure 4. Two ways of attacking: a. from back curve; b. from front curve

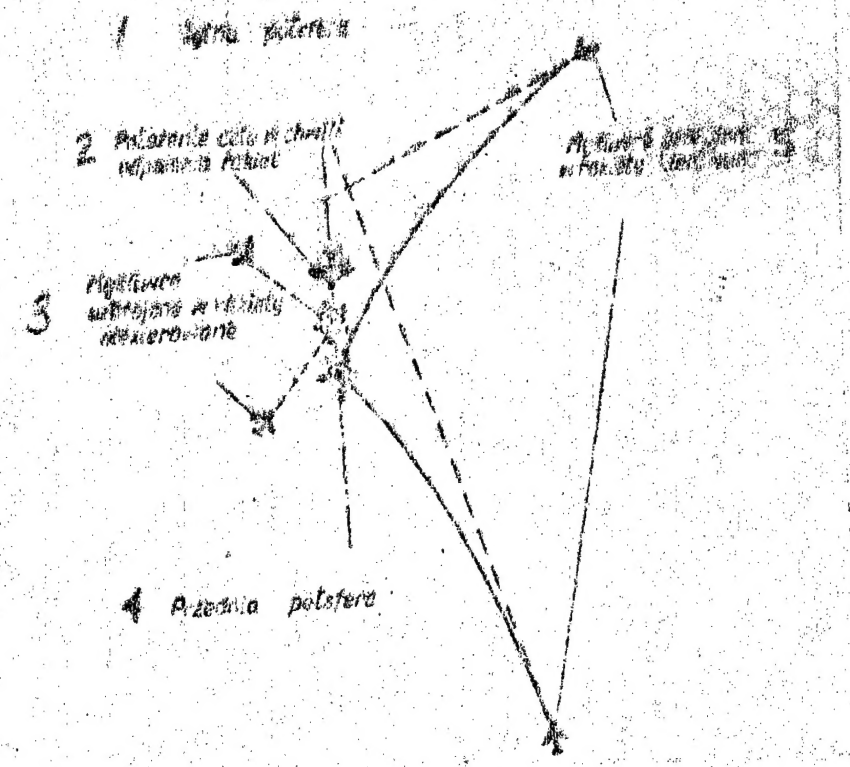

Figure 5. Diagram of front and back curve attack by fighters equipped with missiles and guide rockets. (1 - Back hemisphere, 2 - Position of target at the time of firing the rockets, 3 - Fighters armed with missiles, 4 - Front hemisphere, 5 - Fighters armed with guided rockets.)

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